Reducing Sprains and Strains In Construction Through Worker Participation

A Manual for Managers and Workers With Examples from Scaffold Erection

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Contents

Summary

Scaffold erection work is physicall demanding. It requires manual handling, lifting, and carrying of heav materials and work in awkward postures. As a result, scaffold erectors suffer from a relatively high rate of work-related injuries, most of them musculoskeletal.

This manual presents ways to make the work safer, based largely on ideas from workers. When workers help develop a manual, the proposed solutions are practicable and relatively easy to implement. In addition, this active involvement of workers — "participatory ergonomics" — tends to result in more-motivated workers, less absenteeism, higher-qualit work, and better productivity.

Using the methods described here, pilot projects were conducted in two scaffolding firms in the Netherlands, one small (15 scaffold erectors) and one medium size (50 erectors).

The two companies each completed six steps:

1. Organize the program
2. Have workers list sprain-and-strain hazards
3. Get ideas and choose some solutions
4. Test some solutions
5. Implement the best solutions
6. Evaluate the program.

The main hazards turned out to be related to lifting, lowering, and otherwise moving materials. For all hazards, potential solutions were generated in special brainstorming sessions. All of the participating scaffold erectors graded the potential solutions 1 to 10, with 1 being "unrealistic" or "impossible" and 10 meaning "excellent and easy to do."

Proposed solutions were implemented in a trial. The evaluation found that several solutions are eas to implement and help reduce the physical workload. The most feasible solutions included a plank doll (pallet truck), an electrical winch, shorter ladders and boards, and shoulder protectors. In particular, shoulder complaints were reduced. Almost all of the participating scaffold erectors said they preferred to work with the developed solutions.

Management at both firms found the participator ergonomics a positive experience and said this approach can be applied easily in other companies.

Although specific examples relate to scaffolding, this method can be applied to other work tasks or situations.

Background

Scaffold erection work is physicall demanding. It requires manual handling, lifting, and carrying of heavy materials and work in awkward postures. As a result, scaffold erectors suffer from more health complaints than most other tradesmen. (This is documented in the research literature.) More than half of the serious health complaints are related to musculoskeletal injuries, compared with one in three for construction overall.

In 1990, Arbouw distributed a questionnaire among scaffold erectors in the Netherlands. (Arbouw is the Dutch construction industry's program for safety and health research and promotion.) The results — based on responses by 100 of those polled — show that almost all scaffold erectors work with heav loads. The exact question was, "Do you often work manuall with (too-) heav loads?" More than 80% of the respondents reported that serious physical strain is a common aspect of their work. For 88%, manual handling is the usual way of transporting and lifting materials.

Given these problems, the researchers sought to develop solutions that would meet the needs of scaffold erectors and be eas to implement. The approach used, known as participator ergonomics, enlists workers to improve work practices to reduce sprains and strains. Workers are well aware of the shortcomings, bottlenecks, and other problems in their work. The use of their insights can produce effective solutions that workers readily adopt.

Management at two scaffolding firms used participatory ergonomics to reduce the physical workload of the workers. A staff safety expert and workers used a step-by-step approach to develop solutions for hazardous aspects of the work.

This manual describes how to use participator ergonomics and presents such solutions for scaffolding. Action boxes throughout the text specif agendas for meetings to move the program forward. Sample questionnaires and other documents are in appendixes A through E. The approach is one that can be applied to many other aspects of construction work.

Thus, the manual is set up to accommodate two different approaches. Odd-numbered pages — page 1, 3, 5, and so on — have general information about organizing a company program to reduce sprains and strains. Even-numbered pages (on the left side) provide some details about the scaffolding program, such as scaffolding hazards and scaffold-specific solutions. Please note: *The even-numbered pages should not be given to scaffold-erection workers during a worker-participation program. Having such detailed information in advance might discourage creative suggestions.*

Any company can use this manual to develop and implement its own improvements. Success depends on having workers and management closely follow the steps outlined here. The outcome should be improved safety and productivity.

How to Develop a Company Program to Reduce Sprains and Strains

It is not eas to implement new work practices. A key reason is that it is normal to resist change, - even if the outcome is likel to be an improvement. Because workers are familiar with an old set of procedures, it can take time to implement new methods, tools, or materials. During such a transition, management and supervisors must demonstrate tact and flexibility. In addition, worker participation in the process is essential.

Worker participation is more than a brief discussion or the transfer of information. A step-by-step approach is best, with a mix of large-group and tool box meetings. These are the steps to follow:

1. Organize the program
2. Have workers list the hazards
3. Get ideas and choose some solutions
4. Test some solutions
5. Implement the best solutions
6. Evaluate the results.

Step 1. Organize the progra

To begin the process, participants should indicate their support for it. Top management, middle management, and worker representatives should meet formall and agree unanimousl to work toward a successful project. The group should set up a steering committee and define its responsibilities. The company owner should appoint a program manager to manage the process. Management should make clear at the outset that every suggestion is worth considering — none should be ruled out immediately and no worker will be fired or otherwise punished for expressing an opinion on the committee.

Members of the steering committee should include:

- One or two workers (depending on company size)
- A general foreman (a team leader on the job)
- A project manager (usually a supervisor of a large site or more than one site)
- The general manager.

Workers on the committee should include one member of each trade in the company that does the work. For instance, if carpenters and painters finish drywall, both should participate in a steerin committee on drywall finishing.

A technical expert — an ergonomist or industrial hygienist — should attend every meeting and be available for consultation throughout the process. The expert should be able to assess the effect of all proposed solutions on worker sprains and strains.

Small firms may want to work on this program with one or two other small companies to cut program costs for the tryouts and the technical expert. And having a larger pool of people may help produce more good ideas.

1st meeting of the steering committee

- Introduce all committee members and the program goals.
- Explain the step-by-step approach.
- Agree on how the results of committee meetings will be reported
- Plan for step 2.
  — Prepare for toolbox talks or other ways to tell all workers about the program. Assign responsibilities for preparing toolbox talks or printed handouts.
  — Arrange supplies (pencils, paper) for workers to list all the hazards.
- Set a time for the next steering committee meeting.

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Scaffold erection hazards

Two companies in the Netherlands tried the participatory ergonomics approach. This section provides suggestions based on those companies' experience. (It is best to keep this list onl for reference by the steering committee. If people in toolbox meetings are not given suggestions in advance, the may think of more ideas. And, people tend to be more enthusiastic about their "own" ideas and solutions.)

The scaffold erectors listed the following hazards on their questionnaires.

- Moving and storing materials - Supplying them and moving them on the ground. Materials are often stored on site in the wrong order and too far from scaffolding. Moving the materials to the scaffold adds unnecessary physical strain. The ground is not always level enough to move materials by cart.
- Lifting and lowering of materials - Scaffold erectors say the manual vertical transport o materials along the scaffold is the part of the job that causes the most strain.
- Hea materials - Examples are ladders, boards, and pipes longer than 13 feet. (The workers divided materials into two categories, regular and heavy. The workers considered the handling of heavy materials as a separate hazard.)
- Cooperation on teams - Failures to communicate or cooperate can lead to delivering the wrong parts to the scaffold erectors.
- Other hazards - These include pressure on the shoulders when carrying loads or mounting parts above head level. Scaffold erectors say the cleaning of scaffold parts when dismantling is a strain.

Compared with a group of 7,000 workers in all occupations in the Netherlands who also reported their health complaints for the preceding year, the scaffold erectors reported a higher rate of shoulder problems (fig. F-1). In the Netherlands, no other musculoskeletal complaints from the scaffold erectors were significantly higher than among other workers.

Step 2. Tell everyone about the program and have workers list the hazards

The first toolbox talk(s) for the program should describe the step-by-step approach to everyone who might be involved. The program manager should meet with workers and foremen in small groups to encourage discussion, with no more than 15 people at a time. Talk about the program goals and the step-by-step approach.

Invite everyone to fill in the questionnaire about sprain-and-strain hazards on the job (appendix A). The questionnaire should be filled out at the meeting. Call a 10-to-15-minute break; this gives the technical expert time to review the completed questionnaires. After the break, ask the technical expert to present the questionnaire results. The group should then discuss the hazards to make sure everyone understands them.

On the same day or within a few days, the program manager should meet and discuss the program with everyone else who will work on it — for instance, planners, storage personnel, and equipment movers. (These meetings do not need to be formal meetings.)

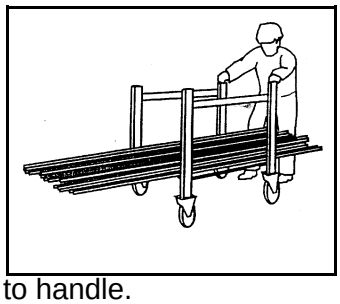
1st toolbox meeting(s) for workers and foremen

- Explain the program.
- Tell who is on the steering committee and what it will do.
- Everyone fills out the questionnaire and lists sprain-and-strain hazards.
- Have the group decide how they will be informed about the project while it is under way — e-mail; someone to telephone them, as needed; or a weekly memo, for instance.

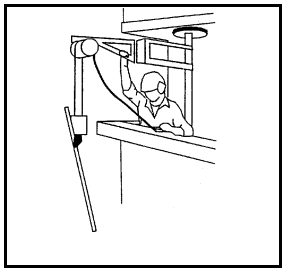
After each meeting, the technical expert should focus on bottlenecks in categories like these:

- The supply of materials and their transport on ground level
- Lifting and lowering materials
- Materials — their weight and usabilit
- Other physical effects (such as, pressure on the shoulders from heavy loads)
- Cooperation within teams
- Other aspects.

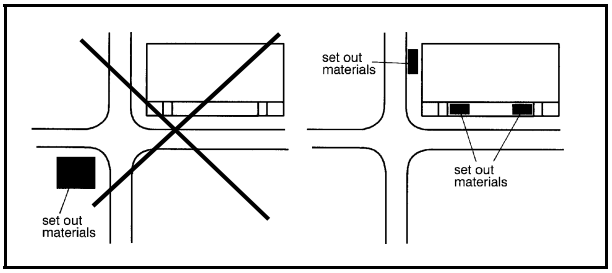
Scaffold erection: Solutions in the pilot projects



- Placement of materials close to the spot where the scaffold is to be built and in the right order.(Sometimes materials needed first were at the bottom of the dolly).
- Development of a plank dolly. Important specifications were:
  - Large wheels for transport over uneven surfaces
  - They should be arranged like a plank dolly
  - Their dimensions should be small enough to pass through gates and doors.
- Ladders no more than 10 feet long. Longer ladders are difficult to handle.
- Electrical winches for lifting and lowering.
- Boards no longer than 13 feet. Longer boards are too hea — more than 60 pounds — especially when wet (see Dutch guidelines for manual handling, appendix B).



- A work plan, including plans for unloading. Movement of materials can be reduced if materials are put together that need to be used together.
- Shoulder pads in workclothes. Although carrying should be eliminated as much as possible, workers will still need to carry some materials on their shoulders. The pads should cover a large area and be waterproof.
- A scaffold that must be dismantled should be cleaned first by the contractor who used it. This point can be included in a contract.



The first five solutions were tested in pilot projects. The last three solutions were tried without testing; the steering committees were confident that they would work.

Later, a model for a lightweight platform was developed (but it is not yet available for sale). It is made of a fiber-reinforced synthetic material and less than hal the weight of the traditional wooden one. The ne platform is more expensive, but the Netherlands researchers believe the extra costs will be compensated for by higher productivity and less absenteeism.

Step 3. Get ideas and choose some solutions

2nd meeting of the steering committee
- Go over the list of hazards from questionnaires (appendix C).
- Choose hazards for further consideration.
- Set criteria the solutions should meet.
- Set a time for the next committee meeting.
- Set toolbox meetings with workers and foremen.

The steerin committee will go over questionnaires that were filled out in toolbox meetings and will make a list of hazards for further consideration. The committee will also set criteria for solutions — such as payback time or the maximum amount to be invested.

Toolbox meetings are essential to the program.
The best solutions for major problems usuall come from toolbox meetings. At each meeting, to get ideas, put up a sign, a slide, or a video showing each hazard. One hazard might be carryin parts on a shoulder. Ask each person to write down ideas for improvements on his or her own paper. You may also want to add some solutions; suggestions for scaffolding are listed in appendix C.

Then, one at a time, ask people to give their ideas and discuss their pros and cons with the group.

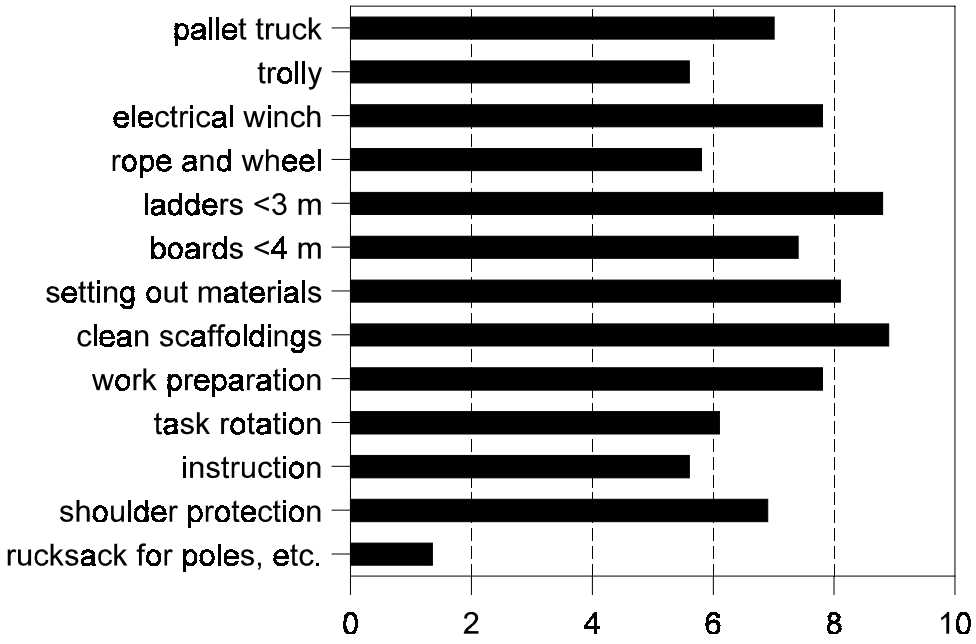
Toolbox session(s) to think up solutions - no more than 15 people per meeting
- Tell what the session is for.
- Explain the hazards that are listed.
- For each hazard, each person lists ideas for solutions.
- Discuss likely effects — good and bad — of each proposed solution:
  -Equipment that is needed and whether it is available
  -The likely effect of the change on how the work is done
  -Likely costs
  -Likely benefits, including effects on sprains and strains (with input from the technical expert).
- A list of all potential solutions and their likely effects should go to the steering committee.

After each toolbox session, you should have a list of all potential solutions and their likel effects. From these lists, the steering committee will select the solutions that appear to be realistic.

Scaffold erection: Solutions in the pilot projects (cont'd from page 10)

Scaffold erectors and foremen gave most of the changes high scores, indicating acceptance:

Average ratings of changes by 60 scaffold erectors and foremen, two firms, the Netherlands, 1994



3d meeting of the steering committee

- Review lists of proposed solutions and likely effects (from toolbox meetings).
  (The committee may want to refer to appendix D.)
- Check: Do the proposed solutions meet the criteria that were set earlier
- Select (feasible) solutions to be presented to all workers.
- Plan a meeting to present the potential solutions to all workers.
- Set a time for the next committee meeting.

The program manager should call a meetin for all the company's scaffold erectors and foremen and give everyone a copy of the steerin committee's list of possible solutions. Each solution is described; a drawing is added where needed. Each scaffold erector or foreman should grade each solution on the list from 1 to 10. A "1" is given to unrealistic or impossible solutions. A "10" means excellent, easy to do. Copies of the lists are all turned in to the program manager.

After countin the average ratin of each solution, the preferences of the scaffold erectors should be clear. If the overall opinion of a proposal is not clear, everyone should discuss it to be sure there is no misunderstanding.

The committee should discuss the narrowed-down solutions with planners, storage personnel, and equipment movers. Their involvement at this point is needed to gain their support.

Step 4. Test some solutions

The steering committee has to choose which solutions to try. To avoid expensive mistakes, it is a good idea to test potential solutions on a small scale. It is easier to make adjustments in a trial situation. Again, all who will be involved with the improvements should be told about the trial.

4th meeting of the steering committee

- Go over worker ratings of the proposed solutions.
- Choose solutions to try out.
- Discuss likely consequences of the proposed solutions.
- Assign workers to trial teams. (This may be the company's decision or be left to volunteers.)
- Plan the trial projects.
- Decide who will evaluate the trial(s) and how.
- Set a time for the next steering committee meeting.

The program manager should meet with the workers assigned to each trial. Explain clearly the purpose and procedures of the trial. Then start the trials for several weeks. The first days are key to success of the trials. Managers and foremen should watch out for any problems that arise to solve them quickly and adequately.

The technical expert can verify the effects of the improvements and possibly estimate costs and benefits — equipment needed, worker time saved, injuries prevented, and so on. The steering committee can consider the trial results in its next (5th) meeting, about three weeks after the trials end.

5th meeting of the steering committee

- Hear and discuss reports of the trial teams.
- Decide which solutions to implement.
- Plan a session with all workers.
- Set a time for the next committee meeting.

Session with all workers

- The steering committee head reports on experiences of the trial teams.
- Explain the solutions to be implemented and likely effects — good and bad — for workers.
- Explain any goals you are setting. (If a solution for a problem is not immediately obvious, one goal would be to develop a solution.)
- After the whole group discusses the solutions and goals, ask if the group agrees to the changes.

Scaffold erection: Evaluation of the worker-participation process

To evaluate the process, the researchers interviewed program managers in the two pilot firms. In addition, workers were asked to fill in a brief questionnaire. The response rate on the questionnaires were 87% (13 of 15 scaffold erectors) in the smallest firm and 26% in the other. The rate may have been low in the larger firm because the workers are not accustomed to paperwork and management did not push for help on this.

The participatory process

All respondents consider the projects valuable, and more than 60% of them indicate that the information provided and participation were sufficient. The pilot firms stated that the step-by-step approach was part of the success. The medium-size firm wrote:

> The project, Reduction of Physical Strain of Scaffold Erectors, was a positive experience for us. Initial skepticism among scaffold erectors changed into full commitment and participation. Their involvement in the generation of solutions and in the pilots made the project attractive. When implementing the solutions other advantages of the participatory approach became clear. The fact that workers had generated the solutions themselves, made it more easy to get support in practice. The procedure was clear; the frequent feedback to all kept the process vivid. The support of the ergonomists was not onl useful, but in our opinion a necessity for a successful project.

Implementation of improvements

The small firm wrote:

> Some solutions could be implemented immediately:
> - a drawing of the layout of materials for each project
> - the planning and ordering of the supplied materials and parts from the storehouse to site in the order in which they will be used
> - frequent instruction in good working methods
> - the supply of shoulder protection.
>
> Further attention will be given to the other recommendations.
> The development of lightweight boards scaffold board is under way We expect that these can be introduced in 1994.

The project managers of both pilot projects reported that the nine improvements with the highest ratings had been implemented (four had not). Worker participation was an important factor for successful implementation and continuation, according to the managers.

The responding workers reported that all of the selected improvements were implemented, but not on all sites. The workers indicated most improvements were positive. The plank dolly, especially, is a great success. The shorter and lighter-weight ladders and boards reduce physical strain and are easier to handle. Only two of the responding scaffold erectors have used an electric winch, but they are very positive about the effects on the workload. The shoulder protectors and the training in lifting and carrying reduce stress from the work but not the workload.

Step 5. Implement the best solutions

At this point, it is management's responsibility to:
• Plan implementation of (at least) the best solutions
• Buy or produce needed equipment
• Train workers and supervisors
• See that solutions are made part of daily practice
• Monitor the results.

Step 6. Evaluate the results

After the company has tried the new solutions for several weeks, interview some workers (separately or in small groups). You could ask all or a few of the workers to do this, depending on how big the company is.

Ask in detail about their experiences using the new methods: What do the workers think of the changes and do they have suggestions for further improvement? Give the workers time to answer fully.

In a big company, use the questionnaire to guide the discussion; the questionnaire helps you learn whether the solutions are still being used. In a small company — where you may alread know if the solutions are being used — the questions on the questionnaire can still help to bring out any small problems and keep the workers involved.

If a solution isn't being used regularly, it is important to know why. Once you know why, you can change the proposed solution and try it again.

6th meeting of the steering committee

- Report of all implemented solutions and the evaluation of them.
  (The committee may want to look at appendixes E and F.)
- The committee should cover:
  — The participatory process
  — Implementation of changes
  — Whether safety and health has improved
  — Effects on costs and productivity.
- Discuss any potential changes to the solutions that were tried.
- Consider a follow-up evaluation in 12 to 18 months.

Scaffold erection: Evaluation of the process (cont'd from page 16)

Improved health and safet

Any change in the rates of absenteeism and injuries could not be assessed, because of the small number of workers involved.

The two firms were, however, positive about the effects on the workload. Their reactions can be summarized:

> The reduction of physical strain had a positive effect on the working conditions. Some hesitations in the start were the result of "getting accustomed to a ne approach." The new approach, the involvement of scaffold erectors in the whole process, made workers consider their work differently. This consideration resulted in several valuable and some less useful solutions. Other solutions can be tried in the future.

Costs and savings

The medium-size company wrote:

> In man cases practical and financial criteria are very predominant for companies. This project helped us learn that "far-away" solutions can be used and are advantageous for both workers and the company.

Because the management and workers had generated, implemented, and evaluated the solutions, the technical and organizational feasibility was agreed upon. The costs of improvements could be incorporated in the regular budget for investments. The direct costs were a loss of work hours for reorganization and tests. At each firm, three scaffold erectors were bus with the tests for two days (paid by the company, not a client). So those six workers were not available for paid work. All other sessions with scaffold erectors were held in routine company meetings. The steering committee meetings did cost several hours of pay for workers.

Productivit

Productivity gains were considered likely, but were not assessed. In several cases, two scaffold erectors can form a team where three workers were previously needed. In both firms, the projects were considered successful companywide and management does not intend to stud productivity further.

Related Research Documents

Urlings, Ilse J.M. 1994. *Oplossingen bedenken samen met het bedrijf* (Generating solutions in collaboration with workers and management). In: Peter Vink and Jan Dul, eds. , *Lichamelijke belasting tijdens arbeid: wetgeving en oplossingen* (Physical loads at work: legislation and solutions). The Netherlands: Kerckebosch, Zeist, 77-82.

Vink, Peter, Ilse J.M. Urlings, and Edith Wortel. 1994. *Succesvol invoeren van verbeteringen met 'participatieve ergonomie'* (Participatory ergonomics: a way to implement successfully). In: Vink P, Dul J, ed. *Lichamelijke belasting tijdens arbeid: wetgeving en oplossingen* (Physical loads at work: legislation and solutions). The Netherlands: Kerckebosch, Zeist, 69-76.

Appendix A: Questionnaire and Hazards Inventory

Please answer the questions below about working conditions found on most sites.

Shortcomings and bottlenecks

Does the ground need to be leveled before the scaffold is erected
☐ no
☐ yes. If yes, are needed tools available ☐ yes
☐ no

Are needed materials and parts close to where the scaffold is to be built
☐ yes
☐ no

Do workers have to carry parts more than 30 feet
☐ no
☐ yes. If yes, is there equipment to transport the materials ☐ yes
☐ no

Do you often carry materials and parts on your shoulders
☐ no
☐ yes

Are the correct parts and materials ordered and delivered for building the scaffold
☐ yes
☐ no

Do you build scaffolds higher than 40 feet
☐ no
☐ yes. If yes, Do you use equipment to lift and lower parts and materials? ☐ yes
☐ no

Do you often build small scaffolds
☐ no
☐ yes

Do you build according to a drawing
☐ yes
☐ no

Do you handle ladders 13 feet long or longer
☐ no
☐ yes

Do you handle boards of 1.5 inches that are more than 13 feet long
☐ no
☐ yes

Do you handle poles 16 feet or longer
☐ no
☐ yes

Do you handle platforms?
☐ no
☐ yes: Are these used when the height between two levels is more than 6.5 feet?
☐ no
☐ yes

Do you often anchor scaffolds to a building
☐ no
☐ yes: Do you drill when anchoring a scaffold? ☐ no
☐ yes

Do you have enough support for your feet and body when doing this
☐ yes
☐ no

Are scaffolds cleaned by others before you dismantle them
☐ yes
☐ no

Do you often use equipment that belongs to the site owner or general contractor
☐ yes
☐ no

Are there regular meetings for workers to discuss work issues
☐ yes
☐ no

Does your company have written procedures for building a scaffold
☐ yes
☐ no

Have you been trained in how to lift and carry?
☐ yes
☐ no

Is there enough personal protective equipment for your work — ear plugs, hard hats, fall protection, and so on
☐ yes
☐ no

Appendix B
Dutch Guidelines for Manual Handling of Materials by Scaffold Erectors

Arbouw is a nationwide labor-management organization in the Netherlands for the improvement of safety and health in the building and construction industry.

One Arbouw activit is to agree on limits for physical workloads and to give suggestions for improvement. The limits are based on internationally acknowledged scientific research.

The maximum allowable weight is considered safe for 25% of the male population to lift. In practice, workloads still exceed the weight limit, so the limit indicates values that should be met.

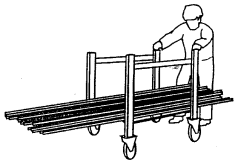
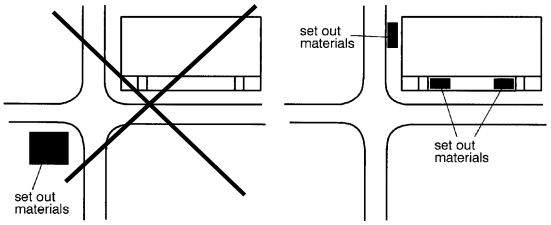
As soon as technical or organization developments make a lower weight-limit feasible, the limit will be reduced.

These are the workload weight limits for individual scaffold erectors:

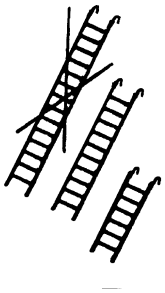
Material	**Workload weight limit for scaffold erectors** (Considered safe for 25% of the male population**)**	**Interim workload limit for scaffold erectors** (Based on economic feasibility)
Scaffold poles, boards, platforms	33 pounds (15 kg.)	51 pounds (23 kg.)

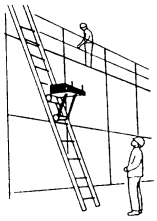
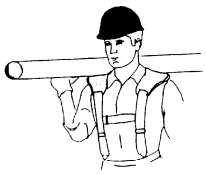
See *A-blad steigerelementen* (Arbouw guidelines for scaffold materials). Amsterdam: Arbouw, 1997.

Appendix C: Potential solutions

Solution	improvement	available	impact
1. Leveling and smoothing	+	+	+/-
HORIZONTAL TRANSPORT			
2. Plank dolly (pallet truck) *Can be used in many but not all situations. Risk of theft. Some extra work.* 	+	-	+
3. Trolley with large wheels and long forks, adapted to the pallets *These can transport many materials and a lot of weight. Careful planning and an even surface are required. Storage and transport of the trolley can be a problem.*	+	+	+
4. Powered plank dolly (pallet truck) *Large wheels and thick tires are needed for transport over lawns. The truck should be narrow to go through gates, doors, and hedges.*	+	-	+
5. Setting out materials near where they will be used on site. *This helps reduce the need for manual transport. Collaboration with the owner of the building or installation is required.* 	+	-	+
6. Materials that will be used together are kept together; parts to be used first are on top of piles of materials. *Preparation for the job should take care of this. Storage personnel must be convinced of the usefulness of this way of organizing materials; they will have to change the way they do things.*	+	+	+/-
7. The loading of containers *If a container is used for transport and no forklift is used, the design of the container should meet the requirements of easy manual handling.*	+	+	+
8. Hand trucks in several formats	+	+	+

Solution	**improvement**	**available**	**impact**
9. Running board for unloading trucks	+	-	+
10. Unloading materials close to scaffolding site	+	+	-
11. Using smaller plank dollies (pallets)	+	-	+/-
12. Using plank dollies (pallets) with wheels or rollers	+	+	+/-
13. A planning system for scaffold parts and tools/equipment.	+	+	-
VERTICAL TRANSPORT			
14. Electrical winch *Electricity is needed. Protect the equipment from theft.* 	+	+	+/-
15. Rope and wheel (manual winch) *Especially useful for scaffolds more than 26 feet high. One (larger) part after another can be lifted. A brake is needed.*	+	+/-	+/-
16. Building the scaffold in modular units, instead of completing each level before putting any parts on the next level up *Especially for long, straight scaffolds*	+/-	+	+/-
17. Erection of scaffolds according to a drawing *If you work from a drawing in which all parts can be seen, there is less chance of making a mistake.*	+/-	+	+/-
18. Loose pulley with a counterweight	+	-	+/-

Solution	improvement	available	impact
LIGHTWEIGHT MATERIALS			
19. Ladders with a maximum length of 10 feet *If the company buys only ladders 10 feet or less, in a couple of years all longer ladders will have been replaced. All scaffolding needs can be met with ladders of 7 to 10 feet.* 	+	+	+/-
20. Boards no longer than 13 feet. *Buy only boards of 13 feet or less. Soon the problem of heavy boards will be over.* 	+	+	+/-
21. Platforms that weigh less than 44 pounds	+	+/-	+/-
22. Aluminum parts, where applicable *There should be no problem up to 19 feet high. Risk of theft.*	+	+/-	+/-
23. Synthetic materials or parts where possible.	+	-	+/-
24. Shorter poles	+	+	+/-
25. Thinner boards	+	+	+/-
ANCHORING A SCAFFOLD TO A BUILDING			
26. Making a wider base to reduce the number of anchors needed *This results in more work to mount the lower part of the scaffold. More materials will need to be transported*.	+	+	-
27. Making an extra horizontal bar at hip height to lean against *A little extra work allows better working postures.*	-	+	+
28. First erecting the scaffold and make sure you have a stable floor before you drill anchor holes *This allows better working postures when drilling.*	+/-	+	+/-
29. Training erectors (and foremen) on how to anchor a scaffold	-	+	+/-
30. Using a lightweight drill	+	+	+
31. Using a counterweight to suspend the tool *The balancer should be battery powered or spring loaded.*	+/-	+	+

Solution	improvement	available	impact
JOB CONTRACT ISSUES			
32. Scaffold must be clean before dismantling *Every worker must keep this agreement, even if this means the scaffold erectors have to wait.*	+	+/-	+/-
33. Layout of the workplace *Materials shall be stored close to the scaffold to be built.*	+	+	+
34. Use of equipment provided by the site owner or general contractor *The use of cranes, ladders, lifts, and so on.* 	+	+	+
COMMUNICATION AMONG SCAFFOLD ERECTORS			
35. Erectors should help prepare a work plan that has step-by-step procedures for mounting *The plan should pay close attention to safety and health*	+	+	+
36. Job rotation *Relieve the worker in the middle, who has the most straining job. Cooperative deliberation is required.*	-	+	+
37. Training in lifting and carrying *All scaffold erectors should be trained. Training should be both part of apprenticeship programs and provided on site.*	+/-	+/-	-
38. Shoulder protection pads *These can be sewn inside the overalls. But scaffold erectors may not wear overalls on warm days.* 	+/-	+/-	+/-
39. Backpack frame for carrying parts	+	-	-
40. Promote the acceptance of equipment	-	+/-	+
41. Improved communication on site	+	+	-
42. Training to select the best materials and parts	-	+	-
43. Make parts easily identifiable — with color or letter codes *This is a means to avoid misunderstandings between scaffold erectors, especially those who are new. It prevents picking and transport of the wrong parts.*	+/-	-	-
44. Lift with both hands to relieve shoulders when carrying	+/-	-	
45. Safety orientation and training on the job	+	+	-

Appendix D: Shortcomings, Bottlenecks, and Potential Solutions

Below, for each answer to the questionnaire, at least one potential solution is listed.

Shortcomings and bottlenecks		**Solutions**
Does the ground need to be leveled before the scaffold is erected ☐ no ☐ yes. If yes, are needed tools available	☐ yes ☐ no →	1
Are needed materials and parts close to where the scaffold will be built	☐ yes ☐ no →	1-13, 33-35
Do workers have to carry parts more than 30 feet ☐ no ☐ yes: is there equipment to transport the materials	☐ yes ☐ no →	1-13, 33-35
Do you often carry materials and parts on your shoulders?	☐ no ☐ yes →	2-13, 19-25, 37, 40, 44
Are the correct parts and materials ordered and delivered for building the scaffold	☐ yes ☐ no →	5-7, 35, 43
Do you build scaffolds higher than 40 feet ☐ no ☐ yes: Do you use equipment to lift and lower parts and materials?	☐ yes ☐ no →	14, 15, 18-25, 35-37, 40, 41, 45
Do you often build small scaffolds	☐ no ☐ yes →	14-25, 35-37, 40, 45
Do you build according to a drawing	☐ yes ☐ no →	5, 17, 35, 41
Do you handle ladders 13 feet or longer	☐ no ☐ yes →	19, 22, 23, 25
Do you handle boards of 1½ inches that are more than 13 feet long	☐ no ☐ yes →	20, 33, 23, 25
Do you handle poles 16 feet or longer	☐ no ☐ yes →	22-24
Do you handle platforms? ☐ no ☐ yes. If so, are these used when the height between platform levels is more than 6.5 feet	☐ no ☐ yes →	21-25

Do you often anchor scaffolds to buildings ☐ no ☐ yes: Do you drill when anchoring a scaffold	☐ no ☐ yes →	28, 30, 31
Do you have enough support for your feet and body when doing this	☐ yes ☐ no →	26-28
Are scaffolds cleaned by others before you dismantle them?	☐ yes ☐ no →	32
Do you often use equipment belonging to the site owner or general contractor	☐ yes ☐ no →	34
Are there regular meetings for workers to discuss work issues	☐ yes ☐ no →	41
Does your company have written procedures for building a scaffold	☐ yes ☐ no →	35
Have you been trained in how to lift and carry safely?	☐ yes ☐ no →	36, 37, 40, 42, 44, 45
Is there enough personal protective equipment for your work — ear plugs, hard hats, fall protection, and so on	☐ yes ☐ no →	38, 39

Appendix E: Measurements to Verify the Hazards and the Solutions

To evaluate and verify the results of improvements, measurements can be made. The technical consultant can conduct the assessments or arrange staff to do so. Measurements that are briefly described here can be used in step 4, where selected improvements are tried out in trial projects.

Changes in heart rate

When someone applies force or moves, the heart rate will increase. Research has shown that the changes in heart rate are a reliable measure of physical strain. For detailed studies, verification of the relation between physical performance and heart rate of an individual can be made on an ergometer, a laboratory bicycle with adjustable resistance.

Questionnaires

A questionnaire on "local musculoskeletal discomfort" is useful. Musculoskeletal health problems and discomfort caused by physical load may have a major effect on employees' productivit and well-being. For prevention and evaluation of sprains and strains, it is important to know the size of the musculoskeletal load. Ratin discomfort by areas of the body — shoulder, lower back, and so on — is an eas way to directly estimate the relative physical load. The questionnaire asks people to identif the areas where they feel discomfort by using a body map and then rate the amount of discomfort. (The questionnaire is not included with this report.)

There is a software program to analyze and present the results of the questionnaire on local musculoskeletal discomfort. The method is a quick and eas way to evaluate changes in sprain-and-strain hazards.

Biomechanical studies

Biomechanical studies of postures make it possible to compute loads on joints. In particular, determining the load on the lower back — the L4/L5 joint — is important for preventing back injuries. The National Institute for Occupational Safety and Health, NIOSH, has developed a procedure to assess the biomechanical load of lifting and carrying and the related force limits.

Productivity

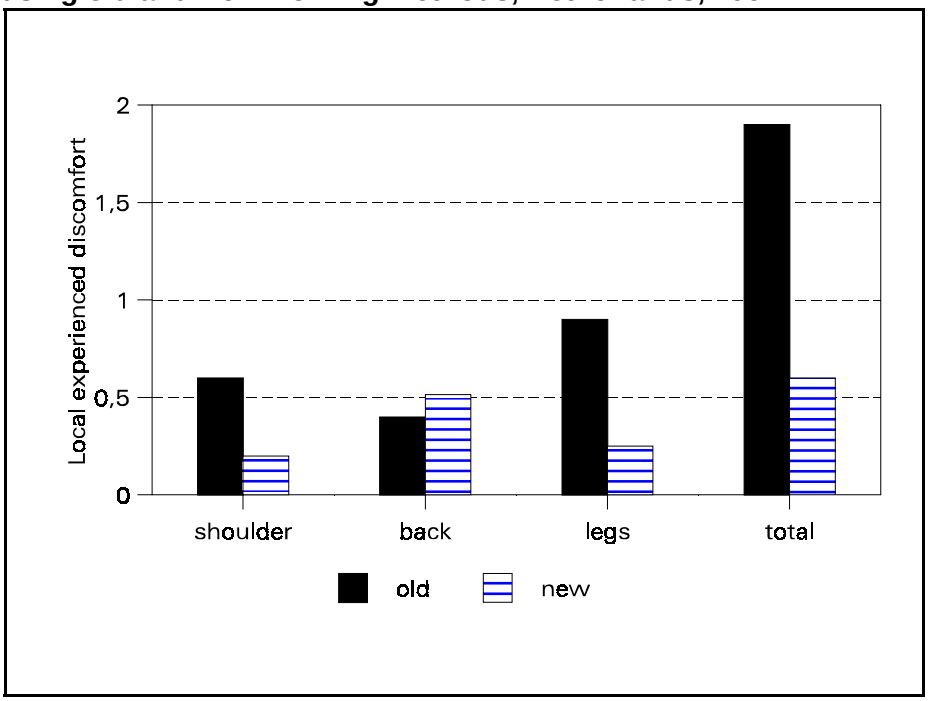
Cost-benefit studies that include productivity can be added to the methods mentioned earlier for evaluating the effects of improvements — before and after the program. For such studies, use the calculation methods the company usually uses.

In the Dutch projects the gain in productivit from only one improvement — settin materials in the right order — was more than 10%, about one hour a day per scaffold erector.

Appendix F
Results of the Scaffold Erection Tryout in the Netherlands

For several weeks, two teams of three scaffold erectors each used the ne methods and materials. The changes were compared with traditional work. (Researchers recorded observations every 30 seconds.)

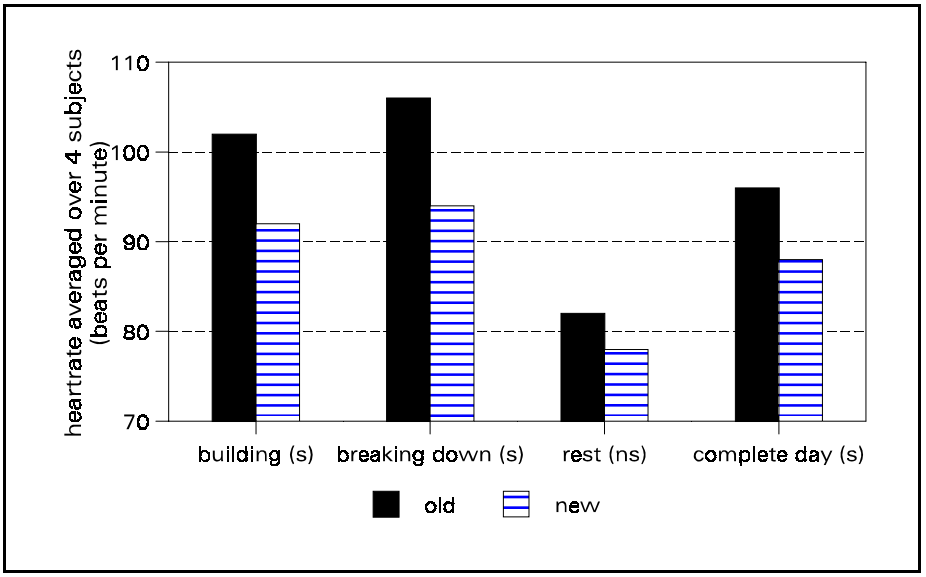
Figure F-1. Average local discomfort reported by 6 scaffold erectors, using old and new working methods, Netherlands, 1994



0= no discomfort
10= extreme discomfort

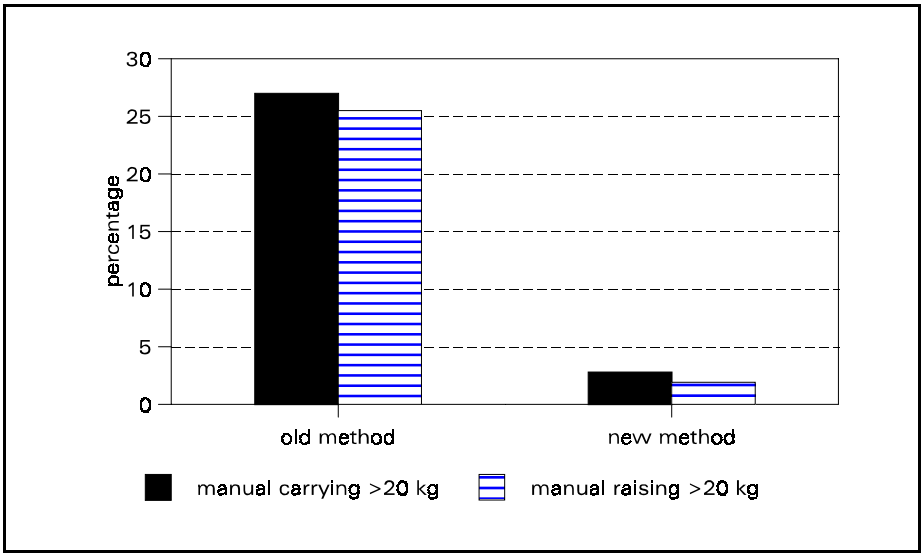
Use of the ne methods significantly reduced four scaffold erectors' heart rates on the job (data on two erectors were lost):

Figure F-2. Heart rates of 4 scaffold erectors, using old and ne methods, Netherlands, 1994



The physical workload decreased because the time that scaffold erectors handled loads of more than 44 pounds was reduced from 25 to 5 % of the total:

Figure F-3. Percentage of time that 6 scaffold erectors carried more than 44 pounds by hand, Netherlands, 1994



Time-and-motion studies showed that discomfort was reduced on workers' shoulders and legs, but not on their backs. With the ne program, workers spend less time with their arms lifted more than 60 degrees:

Figure F-4. Percentage of time that 6 scaffold erectors were observed with an arm elevated more than 60°, using old and new working methods, Netherlands, 1994